

2018 Lyme and Other Tickborne Diseases Surveillance Report

Division of
Infectious Disease
Epidemiology

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Introduction

Lyme disease (LD) is a tickborne disease caused by the bacterium *Borrelia burgdorferi*. It may be transmitted by the bite of *Ixodes scapularis* ticks, also known as blacklegged ticks or deer ticks, if the tick carries the bacteria.¹ Early symptoms, typically occurring in the first 3 to 30 days after a tick bite, include fever, headache, and a rash with a distinctive bull's eye shape known as erythema migrans (EM). The EM rash is not present in approximately 20-30% of cases. Disseminated symptoms, typically occurring days to months after the tick bite, include joint pain and swelling, several EM rashes anywhere on the body, heart palpitations or irregular heartbeat, dizziness, nerve pain, facial palsy, and short-term memory loss. Most cases of Lyme disease can be successfully treated, especially when identified early. Delaying treatment can lead to heart and nervous system-related symptoms.²

In the United States, LD is the most common tickborne disease. Transmission of LD occurs primarily in the Northeast and upper Midwest regions of the country. In 2018, only 15 states reported 93% of all LD cases. In 2018, the last year for which there are national data, Pennsylvania reported more LD cases than any other state. In addition, Pennsylvania had the fourth highest incidence of LD per 100,000 following Maine, New Hampshire, and Rhode Island in 2018.^{3,4} However, states where LD is endemic use a variety of surveillance approaches. Thus, it is difficult to make direct comparisons between states.

Other tickborne diseases can occur in Pennsylvania. The most common of these are anaplasmosis, ehrlichiosis, and spotted fever rickettsiosis (SFR). Anaplasmosis is caused by *Anaplasma phagocytophilum* bacteria, while ehrlichiosis is caused by various species of *Ehrlichia* bacteria. Anaplasmosis is transmitted by the *Ixodes scapularis* tick, the same tick that transmits LD. Ehrlichiosis is transmitted by the lone star tick (*Amblyomma americanum*). SFR is caused by species of *Rickettsia* bacteria and is transmitted by the American dog tick (*Dermacentor variabilis*).^{5,6,7}

Overview

In 2018, 10,208 LD cases were reported in Pennsylvania, representing an incidence of 79.7 cases/100,000 persons. Most were reported between May and August, with about half reported in June and July. All 67 counties in Pennsylvania reported LD, ranging from 10 cases in Montour County to 678 cases in Chester County. Incidence ranged from 12.0 cases/100,000 persons in Philadelphia County to 485.8 cases/100,000 persons in Jefferson County.

In 2018, Pennsylvania reported 108 anaplasmosis cases, 18 ehrlichiosis cases and 25 SFR cases.

Methods

In Pennsylvania, cases of LD, anaplasmosis, ehrlichiosis, and SFR, as well as positive laboratory test results for these diseases, are reportable by providers and laboratories to the Pennsylvania Department of Health (DOH) per Chapter 27 of the Pennsylvania Health and Safety code.⁸ Upon receiving the report, state public health nurses or county/municipal health department staff attempt to collect more information about the case from the ordering physician. The investigator then determines if the reported case meets the Council of State and Territorial Epidemiologists (CSTE)/Centers for Disease Control and Prevention's (CDC) surveillance case definition. In addition, a computer algorithm is used to ensure that LD cases are classified correctly. CDC case definitions, which are designed for standardization of national case counting and are not intended for diagnostic purposes, can be found at <https://wwwn.cdc.gov/nndss/case-definitions.html>.

Cases that were designated as confirmed or probable according to the CSTE/CDC case definition are included in the case counts described in this report. In addition to comparing case counts to those from previous years, seasonal trends, geographic location and characteristics of cases were analyzed. Population data were obtained from the Pennsylvania Department of Health Bureau of Vital Statistics.

DOH also conducts syndromic surveillance of visits to Pennsylvania emergency departments and collects this data via the EpiCenter application by Health Monitoring Systems. EpiCenter collects de-identified data from most hospitals in Pennsylvania to monitor for chief complaint trends. In 2018, data regarding date and reason for visit, home zip code, and other information were obtained from 97% of emergency departments in the state. This information was analyzed to determine seasonal trends in tick-related emergency department visits. Chief complaints were searched for the presence of terms and variant spellings that indicated the patient had found a tick on their body or was bitten by a tick.

Lyme Disease Findings

Annual Trends

In 2018, 10,208 LD cases were reported in Pennsylvania. This represents an incidence of 79.7 cases/100,000 persons in Pennsylvania and was a 14% decrease from the 2017 case count. In 2018, Pennsylvania reported 30% of all LD cases in the United States and ranked first in number of cases reported and fourth in incidence. Although there is an overall increase for Lyme disease reported cases and incidence nationally over the last decade, in 2018, Lyme disease cases decreased in most Lyme endemic states. The national trend in increasing cases may be due to expanded habitat for *Ixodes scapularis* and white-footed mice, which also harbor the *Borrelia burgdorferi* bacteria.⁹ Additionally, *Ixodes scapularis* ticks are more likely to survive winter as the weather warms. Humans are also spreading into rural areas to build homes and participate in leisure activities, making human and tick contact more frequent. Year to year variations are not unusual and may be related to decreased tick activity, decreased white-footed mouse populations, and weather patterns. Table 1 shows the case counts by classification and total incidence by year for the last 10 years.

Table 1 – Lyme Disease Cases by Classification and Total Incidence per 100,000 Population, Pennsylvania, 2009-2018

Year	Lyme Disease Case Count			Population	Lyme Disease Incidence per 100,000
	Confirmed	Probable	Total		
2009	4950	772	5722	12,604,767	45.40
2010	3298	507	3805	12,702,379	29.96
2011	4739	623	5362	12,742,886	42.08
2012	4146	887	5033	12,763,536	39.43
2013	5126	778	5904	12,773,801	46.22
2014	6470	1017	7487	12,787,209	58.55
2015	7655	1772	9427	12,802,503	73.63
2016	8988	2455	11443	12,784,227	89.51
2017	9250	2650	11900	12,805,537	92.93
2018	7920	2288	10208	12,807,060	79.71

Source: PA-NEDSS; Pa. DOH, Bureau of Vital Statistics

Seasonality

LD can be acquired year-round in Pennsylvania; however, most LD cases occur in the late spring and summer months. In 2018, 50.0% of cases with known onset dates reported that their onset of LD symptoms was in June or July. More people spend time outdoors and are more likely to come in contact with ticks in these months. In addition, *Ixodes scapularis* nymphs are most active in the late spring and early summer. Most cases of Lyme disease are attributed to nymphal ticks. Their small size makes them very hard to detect and remove in order to prevent Lyme bacteria transmission. Table 2 shows the months of onset of symptoms of LD by classification status. A higher proportion of confirmed cases were reported in June and July than probable cases. This is likely because acute cases of Lyme presenting with erythema migrans, a symptom which is diagnostic for Lyme disease, are more likely to be quickly diagnosed. Probable cases, which are defined by laboratory criteria and later-stage signs and symptoms, are more likely to be diagnosed after some time has passed.

Table 2 – Lyme Disease by Onset Month*, Pennsylvania, 2018

Month	Confirmed Cases	Probable Cases	Total
January	157	58	215
February	99	53	152
March	138	58	196
April	163	67	230
May	450	129	579
June	1623	319	1942
July	1204	271	1475
August	481	131	612
September	341	98	439
October	437	109	546
November	213	78	291
December	122	54	176
Total	5428	1425	6853

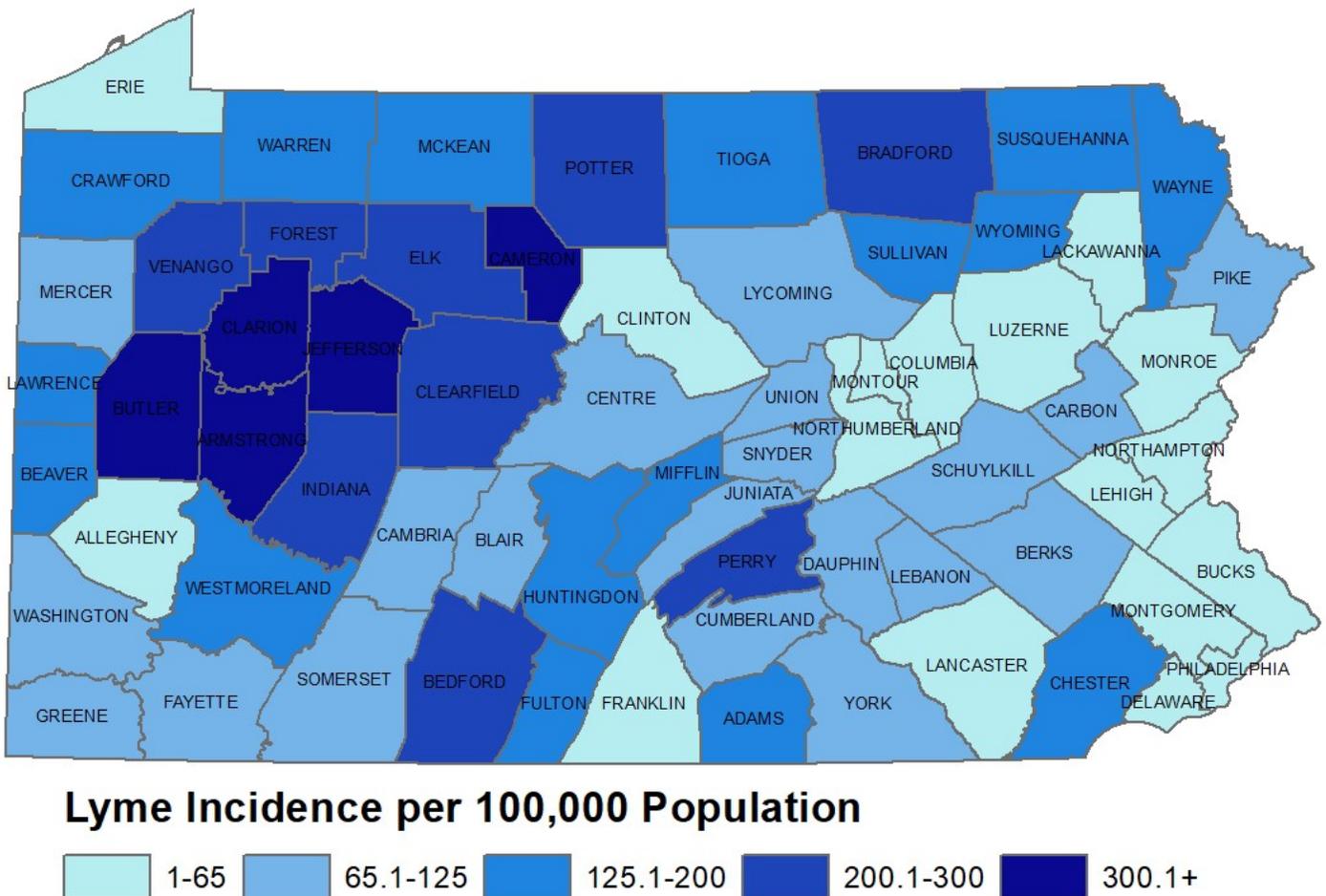
Source: PA-NEDSS

* Onset date is unknown for 33% of cases.

Geographic Distribution

Ixodes scapularis ticks infected with *Borrelia burgdorferi* have been found in all 67 counties in Pennsylvania. Persons have also been diagnosed with LD in all counties in Pennsylvania. LD incidence varies by county. Urban areas like Philadelphia tend to have a lower incidence than nonurban counties. In addition, because classifying cases of LD requires data from providers to be reported to public health nurses in Pennsylvania’s health departments, case counts could appear lower in counties with lower staffing levels or in areas in which providers are less likely to respond. Due to these surveillance complexities, the counties reporting the most cases may not actually have the greatest burden of Lyme disease. In 2018, counties in the northwest area of the state reported the highest incidence of LD. Map 1 shows the county incidence of LD cases in 2018. Table 3 shows the case counts by county in 2018.

Map 1 – Lyme Disease Incidence per 100,000 by County, Pennsylvania, 2018



Source: PA-NEDSS; Pa. DOH, Bureau of Vital Statistics

Table 3 – Lyme Disease Case Counts by County, Pennsylvania, 2018

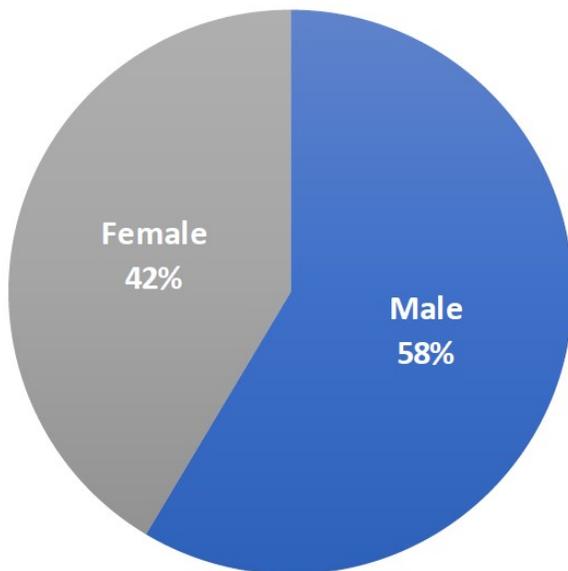
County	Lyme Disease Case Count	County	Lyme Disease Case Count
Adams	137	Lackawanna	125
Allegheny	404	Lancaster	309
Armstrong	216	Lawrence	112
Beaver	254	Lebanon	92
Bedford	133	Lehigh	209
Berks	279	Luzerne	181
Blair	118	Lycoming	88
Bradford	161	McKean	83
Bucks	398	Mercer	75
Butler	624	Mifflin	59
Cambria	137	Monroe	105
Cameron	15	Montgomery	463
Carbon	55	Montour	10
Centre	195	Northampton	88
Chester	678	Northumberland	60
Clarion	187	Perry	110
Clearfield	221	Philadelphia	190
Clinton	20	Pike	59
Columbia	41	Potter	49
Crawford	126	Schuylkill	140
Cumberland	177	Snyder	35
Dauphin	189	Somerset	58
Delaware	156	Sullivan	12
Elk	67	Susquehanna	74
Erie	111	Tioga	61
Fayette	103	Union	48
Forest	16	Venango	153
Franklin	48	Warren	53
Fulton	25	Washington	207
Greene	31	Wayne	86
Huntingdon	67	Westmoreland	496
Indiana	201	Wyoming	50
Jefferson	212	York	448
Juniata	18	Total	10208

Source: PA-NEDSS

LD Case Characteristics

Nationally, LD is more commonly diagnosed in males. This pattern was seen in the 2018 Pennsylvania LD data as well, with males comprising 58% of reported cases. Males may spend more time engaging in outdoor activities, such as camping and hunting, may be more likely to do yard work, and may be more likely to have jobs that require work outdoors. Figure 1 shows the sex distribution of LD cases in 2018.

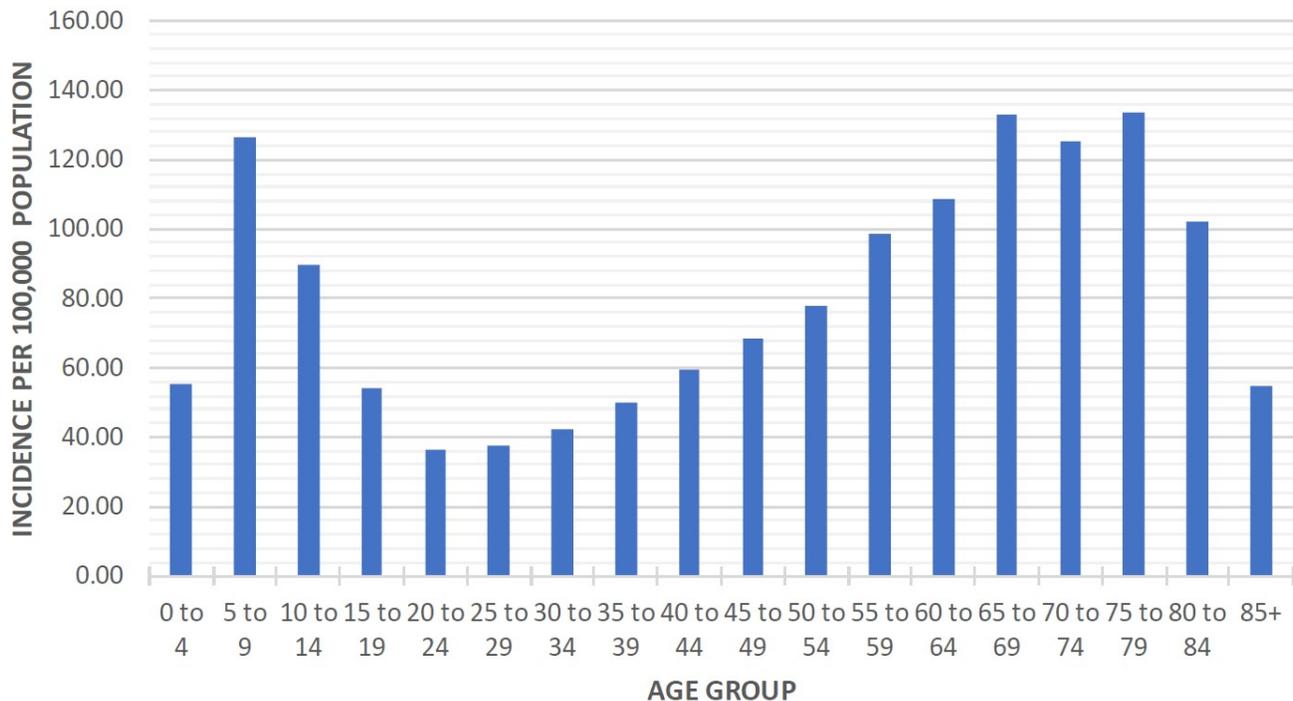
Figure 1 – Lyme Disease by Sex, Pennsylvania, 2018



Source: PA-NEDSS

LD incidence was highest in children ages 5-9 and in older adults. This is consistent with national trends. Children in the 5-9 year age group are more likely to play outside, are lower to the ground, may cuddle more with pets who might have ticks, and are more likely to play in leaves and tall grass. There is also a high incidence in older adults. The reason for this is not clear but may be due to more severe symptoms resulting in an increased likelihood to seek care for Lyme disease-related symptoms, and/or increased time post-retirement to participate in outdoor leisure activities, such as dog walking, gardening, bird watching, and nature walks. The age-adjusted LD incidence for 2018 is 80.8 cases per 100,000 persons. Figure 2 displays the incidence of LD by age groups in 2018.

Figure 2 – Lyme Disease Incidence by Age Group, Pennsylvania, 2018



Source: PA-NEDSS; Pa. DOH, Bureau of Vital Statistics

Clinical Manifestations of LD

The erythema migrans rash is the most distinctive sign of LD; 47.1% of Pennsylvania cases in which the data were available were reported as having the classic rash. It should be noted that, according to CDC, EM is diagnostic for LD, and treatment should be initiated. Lab testing is not required in this circumstance, and serologic tests may be negative if done too soon after the onset of illness. Since most LD cases are reported to DOH by laboratories, it is likely many cases diagnosed on the basis of EM alone are not reported to the department at all. Therefore, the proportion of cases with EM seen in our data are likely an underrepresentation of the true incidence of EM in LD cases. As noted earlier, there are a number of other signs and symptoms associated with different stages of LD. More serious complications of LD, like meningitis, encephalitis, and atrioventricular block, are rare. Table 4 shows the frequency with which the most common signs and symptoms of LD were reported in 2018. In cases in which the onset date of symptoms was reported, the median number of days between symptom onset and diagnosis of LD was nine days. However, onset date is not always reported and may be less likely to be reported in cases that have been experiencing LD symptoms for a longer period of time, since these cases may not remember when their LD symptoms began.

Table 4 – Signs and Symptoms of Lyme Disease Reported by Providers Among Lyme Disease Cases, Pennsylvania, 2018

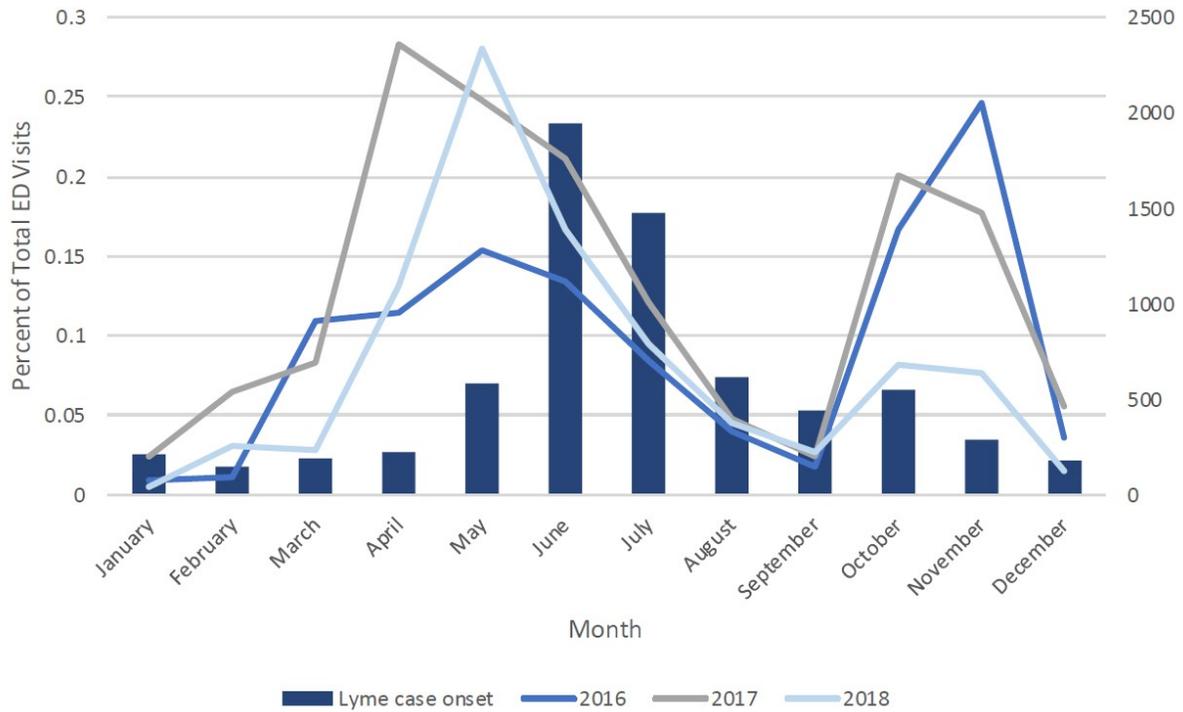
Symptom	Percent (%) Who Reported Experiencing this Symptom
Erythema migrans (EM)	47.1
Joint swelling	37.3
Bells palsy	5.5
Radiculoneuropathy	3.4
Lymphocytic meningitis	0.3
Encephalitis/encephalomyelitis	0.4
Second or third degree atrioventricular block	0.7

Source: PA-NEDSS

Tick Bites

A review of syndromic emergency department surveillance data revealed an increase in visits attributed to tick bites occurred in April 2018, when weather warmed and people were more likely to spend time outdoors. This is consistent with prior years. This coincides with increased adult *Ixodes scapularis* activity, as well as *Dermacentor variabilis* (dog tick) activity. *Ixodes scapularis* nymphs emerge in late spring and early summer. Tick bite complaints, which are inclusive of several species of ticks, are still elevated during late spring and early summer despite *I. scapularis* adult activity decreasing. *I. scapularis* nymphs, however, are active from late May to mid-July, which corresponds with the spike in LD reports with onset date in June and July. These cases do not appear to be associated with visits to the emergency department (ED) for tick bites; it is possible that nymphal activity is less noticeable and results in fewer ED visits, although these bites still contribute to LD incidence. There is a second peak in tick-related emergency department complaints in the fall, which is consistent with the fact that adult *I. scapularis* ticks feed during October and November. Figure 3 shows the timing of tick-related complaints reported in Pennsylvania emergency departments in 2015-2018. Since tick bite-related emergency department visits peak prior to the peak of Lyme incidence, this indicates persons may be more likely to present to the emergency department with an adult tick bite than a nymphal tick bite.

Figure 3 – Tick-Related Emergency Department Chief Complaints, Pennsylvania, 2016-2018



Source: Health Monitoring Systems; PA-NEDSS

Tickborne Rickettsial Infections (TBRI) Findings (Anaplasmosis, Ehrlichiosis, Spotted Fever Rickettsiosis)

Annual Trends

Ehrlichiosis and spotted fever rickettsiosis (SFR) case counts have been steady in Pennsylvania over the last 10 years, with counts typically ranging between 10-30 cases per year. Anaplasmosis, on the other hand, was infrequently reported a decade ago but has increased steadily to a high of 108 cases in 2018. Ehrlichiosis and SFR are transmitted by *Amblyomma americanum* (the lone star tick) and *Dermacentor variabilis* (the American dog tick), respectively. Anaplasmosis is transmitted by the *Ixodes scapularis* (deer tick), the same tick which transmits LD. Tick surveys have shown that the geographic range of *I. scapularis* has increased in Pennsylvania and the density of *I. scapularis* ticks has increased as well.⁸ This likely accounts for the increase in *I. scapularis* transmitted infections like anaplasmosis. In 2018, Pennsylvania reported 108 anaplasmosis cases, 18 ehrlichiosis cases and 25 SFR cases. Table 5 shows the case counts of these 3 tickborne diseases over the last 10 years.

Table 5 – Anaplasmosis, Ehrlichiosis and SFR Case Counts, Pennsylvania, 2009-2018

Year	Anaplasmosis	Ehrlichiosis	Spotted Fever Rickettsiosis
2009	2	32	23
2010	1	5	15
2011	6	10	19
2012	8	23	41
2013	34	28	16
2014	25	10	7
2015	21	14	16
2016	58	23	22
2017	94	19	28
2018	108	18	25

Source: PA-NEDSS

Seasonality

Onset months of TBRI cases differ slightly from typical onset months of Lyme disease. We do see most cases in warm months, as ticks are most active in the warmer months and people are more likely to be outdoors and exposed to ticks during these months. However, anaplasmosis cases are more likely to report onset dates in May, June, and October. This trend may indicate that adult *I. scapularis* cases are more likely to transmit anaplasmosis than nymphs are, given that nymphs are most active in June and July. Table 6 shows the 2018 cases of other tickborne diseases by month of report. Ehrlichiosis and SFR are transmitted by *A. americanum* and *D. variabilis*, respectively, which have different life cycles than *I. scapularis*.

Table 6 – Anaplasmosis, Ehrlichiosis and SFR Case Counts by Month of Onset, Pennsylvania, 2018

Month of Onset Date	Anaplasmosis	Ehrlichiosis	Spotted Fever Rickettsiosis
January	1	0	0
February	0	0	0
March	0	2	2
April	1	0	1
May	18	2	3
June	24	6	4
July	10	1	2
August	10	2	2
September	4	1	1
October	11	3	0
November	5	0	0
December	0	0	0

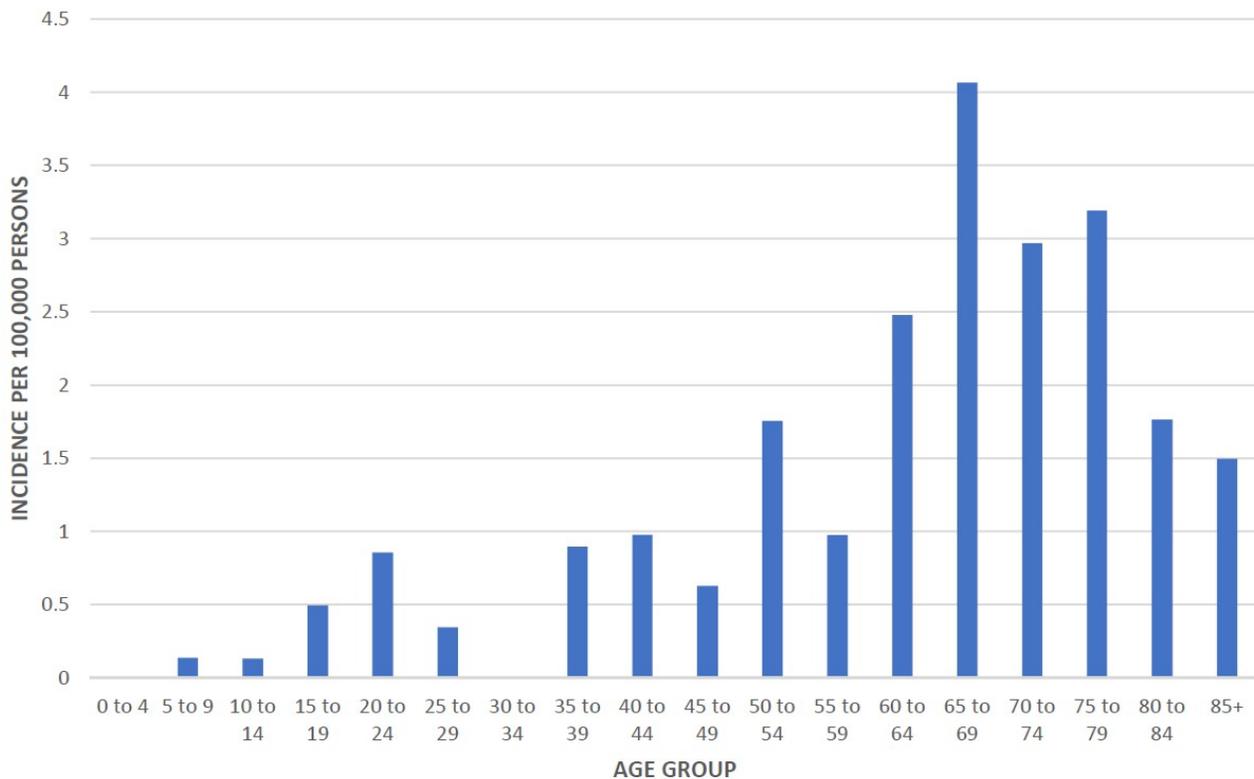
Source: PA-NEDSS

Case Characteristics

Similar to LD, males are more likely than females to report these other tickborne diseases, with 60.3% of cases occurring in males.

However, in contrast to LD, the incidence in young children was low, and there was a higher incidence in older adults and the elderly. The reason for this pattern is not clear. Figure 4 shows the number of cases per 100,000 in each age category.

Figure 4 – Anaplasmosis, Ehrlichiosis and SFR Incidence by Age Group, Pennsylvania, 2018



Source: PA-NEDSS and Pa. DOH Bureau of Vital Statistics

Geographic Distribution

In 2018, 44 of 67 counties reported at least one case of anaplasmosis, ehrlichiosis, or SFR. The highest number of cases are reported in the eastern counties of the state. This is primarily driven by anaplasmosis, which has had high case counts in the eastern counties. Case counts have begun increasing in central and western counties, following the same pattern exhibited by LD, which first appeared in eastern counties and then spread westward throughout the state. Centre County has an unusually high number of anaplasmosis cases in 2018. Ehrlichiosis cases do not show a geographic pattern and can be found in counties in all areas of Pennsylvania. Most SFR cases are reported in eastern counties, especially southeastern counties. Table 8 shows the number of TBRI cases by county in 2018.

Table 8 – Anaplasmosis, Ehrlichiosis and SFR Case Counts by County, Pennsylvania, 2018*

County	Anaplasmosis	Ehrlichiosis	SFR
Allegheny	*	0	*
Armstrong	5	0	0
Beaver	0	*	*
Berks	0	0	*
Blair	0	0	*
Bradford	0	*	0
Bucks	*	*	*
Centre	20	0	0
Chester	12	*	*
Clearfield	6	0	0
Clinton	*	0	0
Columbia	*	0	0
Crawford	0	*	0
Cumberland	*	0	*
Dauphin	5	0	0
Delaware	*	*	*
Elk	*	*	0
Erie	*	*	0
Forest	*	0	0
Franklin	*	0	0
Huntingdon	*	0	0
Jefferson	*	0	0
Lackawanna	0	0	*
Lancaster	0	*	*
Lehigh	*	0	0
Luzerne	*	0	0
McKean	*	0	*
Mercer	0	*	0
Monroe	7	*	*
Montgomery	*	*	*

Montour	*	0	0
Northampton	*	*	0
Perry	0	0	*
Philadelphia	*	0	*
Pike	*	0	0
Potter	*	0	0
Schuylkill	*	0	0
Snyder	*	0	0
Union	*	0	*
Venango	*	0	0
Warren	*	0	0
Wayne	*	*	0
Westmoreland	*	0	*
York	*	0	*

Source: PA-NEDSS

*Case counts <5 have been redacted in accordance with Pa. DOH policy.

Citations

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- ⁹ Sonenshine, D. (2018) “Range Expansion of Tick Disease Vectors in North America: Implications for Spread of Tick-Borne Disease.” *Int J Environ Res Public Health*. Mar; 15(3): 478.